User's Manual

E1/E20 Emulator, E2 Emulator Lite

Additional Document for User's Manual (Notes on Connection of RL78)

Supported Devices:

RL78 Family

RL78/D1A, RL78/F12, RL78/F13, RL78/F14, RL78/F1A,
RL78/G12, RL78/G13, RL78/G14, RL78/G1A,
RL78/G1C, RL78/G1D, RL78/G1E, RL78/G1F, RL78/G1G,
RL78/I1A, RL78/I1B, RL78/I1D,
RL78/L12, RL78/L13, RL78/L1C

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Contents

Terminology

Some specific words used in this user's manual are defined below.

Host machine
This means a personal computer used to control the emulator.

User system
This means a user's application system in which the MCU to be debugged is used.

User program
This means the program to be debugged.

Programming Software
In this document, this indicates Renesas Flash Programmer that can be used with the E1, E20, or E2 Lite.

"#" at the end of a pin name (signal name)
"#" at the end of a pin name (signal name) indicates that the pin (signal) is active low (e.g., RESET#).

1. Overview

1.1. Overview of E1/E20 Emulator and E2 Emulator Lite

In this document, we describe ‘E1 Emulator’ as ’E1’, ‘E20 Emulator’ as ’E20’ and ‘E2 Emulator Lite’ as ‘E2 Lite’.
The E1, E20, and E2 Lite are on-chip debugging emulators for Renesas' mainstream MCUs.
The E1 and E2 Lite are highly affordable development tools providing basic debugging functions. The E20 is a development tool allowing sophisticated debugging through enhanced functions such as tracing and RAM monitoring as well as the basic debugging functions of the E1 and E2 Lite. The E1/E20/E2 Lite can also serve as a Flash Programmer.

1.2. Note on Using E20

To use the large trace function and the real-time RAM monitoring function, which are the primary features of the E20, the target MCU must be equipped with a pin for outputting trace information.
The available functions are equivalent to those of the E1/E2 Lite (only the internal trace function in the MCU and memory reference and modification during execution).
The power supply function from the E20 is not supported.

1.3. Configuration of E1/E20/E2 Lite Manuals

The E1/E20/E2 Lite manuals consist of multiple parts: the E1/E20 Emulator User's Manual, the E2 Emulator Lite User's Manual, and the additional documents for the user's manual for each MCU.
Be sure to read each part before using the E1/E20/E2 Lite.

(1) E1/E20 Emulator User’s Manual

The E1/E20 emulator user’s manual has the following contents:

- Components of the E1/E20
- Hardware specifications of the E1/E20
- Connection to the E1/E20 and the host machine and user system

(2) E2 Emulator Lite User’s Manual

The E2 Emulator Lite user’s manual has the following contents:

- Components of the E2 Lite
- Hardware specifications of the E2 Lite
- Connection to the E2 Lite and the host machine and user system

(3) E1/E20 Emulator, E2 Emulator Lite Additional Document for User's Manual (Notes on Connection of RL78)

The E1/E20 Emulator, E2 Emulator Lite Additional Document for User's Manual (Notes on Connection of RL78) describes information necessary for hardware design such as connection examples, interface circuits, and notes on using the emulator.

(4) User’s manual and help for the emulator debugger

The user’s manual and help for the emulator debugger describe the functions of the E1/E20 emulator debugger and the operating instructions.
Refer to the following for E1/E20.

- CS+ Integrated Development Environment User's Manual: RL78 Debug
- Help for e2 studio
- RL78 Family CS+ Debugging Using Hot Plug-in Function

Refer to the following for E2 Lite.

- Help for e2 studio

When using C-SPY made by IAR Systems, also refer to "IAR C-SPY Hardware Debugger System User Guide issued by IAR Systems" published by IAR Systems.

1.4. Supported Devices

Table 1-1 Supported Device List

Item	Description
Target MCUs *2	RL78 Family (RL78-S2 Core) *1
	RL78/D1x : RL78/D1A
	RL78/F1x : RL78/F12
	RL78/G1x : RL78/G12,RL78/G13,RL78/G1A,RL78/G1C,RL78/G1D, RL78/G1E, RL78/G1F, RL78/G1G
	RL78/I1x : RL78/I1A
	RL78/L1x : RL78/L12,RL78/L13
	RL78 Family(RL78-S3 Core) *1
	RL78/F1x : RL78/F13,RL78/F14,RL78/F1A
	RL78/G1x : RL78/G14
	RL78/I1x : RL78/I1B,RL78/ID
	RL78/L1x : RL78/L1C

*1 For details on the RL78-S2 core or RL78-S3 core, refer to "RL78 Family User's Manual: Software".
*2 When using the RL78/G10, refer to "E1/E20 Emulator Additional Document for User's Manual (Notes on Connecting RL78) (for RL78/G10)".

Table 1-2 Debugging Function List

Item		Type of the RL78 Core		Description
		RL78-S2	RL78-S3	
Memory reference or change during program execution				
Pseudo-real-time RAM monitor(RRM)		Supported	Supported	CPU is used when monitoring
Dynamic Memory Modification(DMM)		Supported	Supported	CPU is used when changing
Event		1 points	2 points (max)	Can be used for hardware break (or trace*1)
Break	Software break	Supported	Supported	2000 points
	Hardware break	Supported	Supported	Commonly used by execution and access
	Forced break	Supported	Supported	
Trace	Acquired information	Not supported	Supported *2	Branch source PC information
	Start event	Not supported	Supported *2	User program execution start and event start
	End event	Not supported	Supported *2	User program stop, event completion, and full trace memory
Performance measurement function	Measurement item	Supported	Supported	Between start and stop of user program execution
	Performance	Supported	Supported	Resolution 100 µs (max) measurement time 119 hours 18 min
Hot plug-in		Not supported	Supported *3	
Coverage measurement function		Not supported	Not supported	

Notes: 1 Only devices in which the trace function was implemented.
2 The trace function is not supported in an RL78/G14 MCU whose ROM size is 64 Kbytes or less.
3 Only RL78/F13, RL78/F14, and RL78/F1A are supported.

2. Designing the User System

2.1. Connecting the E1/E20/E2 Lite to the User System

To connect the E1/E20/E2 Lite to the user system, a connector for the user system interface cable must be mounted on the user system.
When designing the user system, read this section of this manual and the hardware manual for the MCU in use.

2.2. Installing the Connector on the User System

Table 2-1 shows the recommended connectors for the E1/E20/E2 Lite.

Table 2-1 Recommended Connectors

Connector	Type Number	Manufacturer	Specifications
14-pin connector	7614-6002	3M Japan Limited	14-pin straight type (Japan)
	2514-6002	3M Limited	14-pin straight type (other countries)

* Connection to the 38-pin connector of the E20 is not supported. To use the E20, use the 38-pin to 14-pin conversion adapter that comes with the E20 for connection to the 14-pin connector on the user system.

2.2.1. Connecting the User System Interface Cable to the 14-Pin Connector

Figure 2-1 shows an example of the connection between a user system interface cable of the 14-pin type and the E1/E2 Lite.
Figure 2-2 shows an example of connection between the cable with the 14-pin connector and the E20 via the 38-pin to 14-pin conversion adapter.

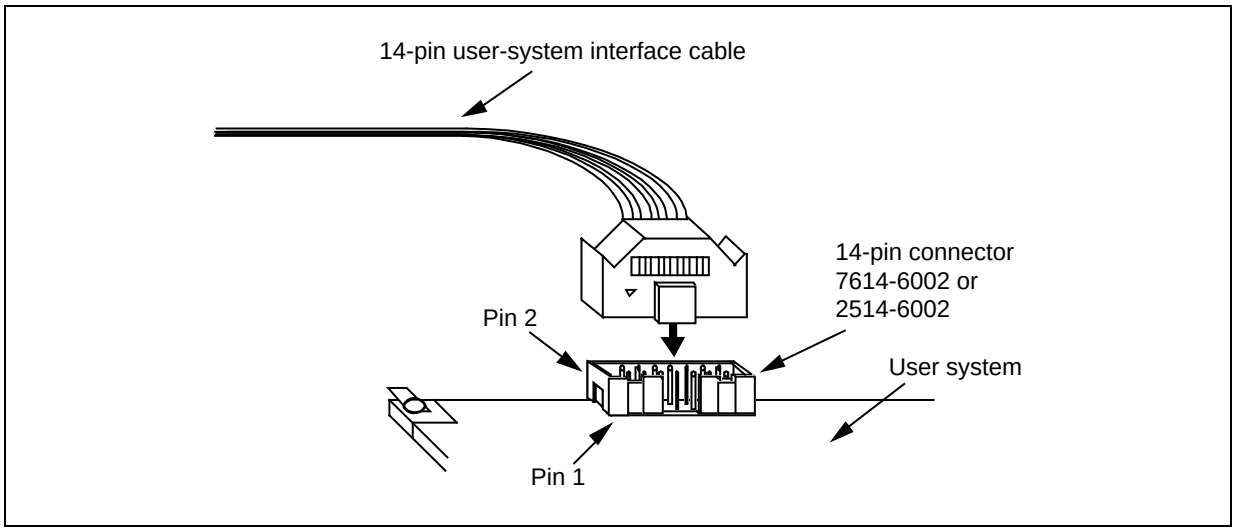


Figure 2-1 Connecting the User System Interface Cable to the 14-Pin Connector of the E1/E2 Lite

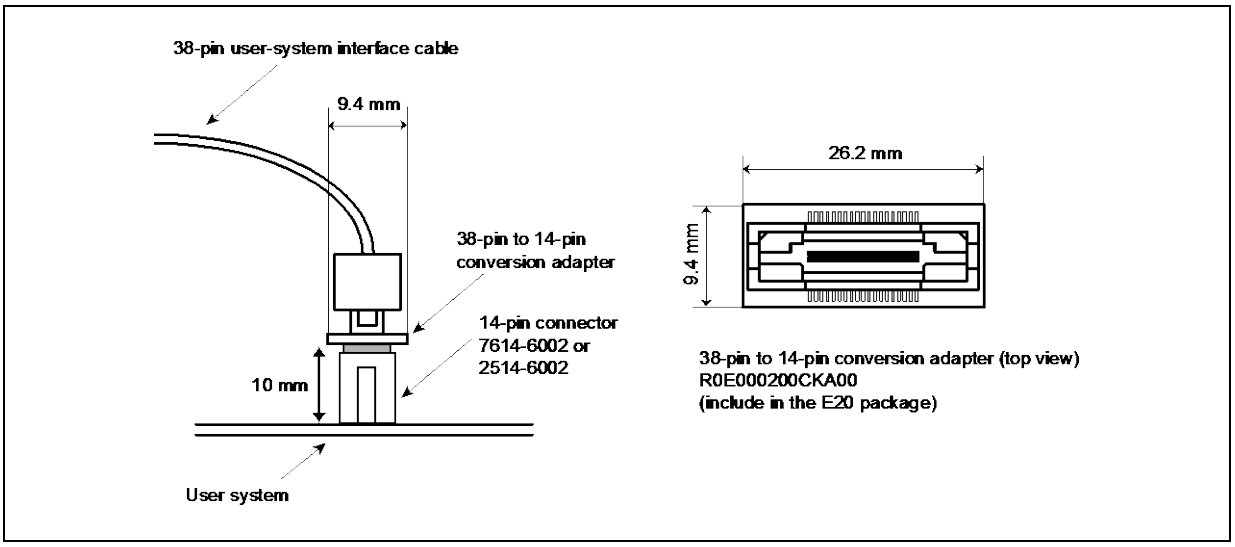
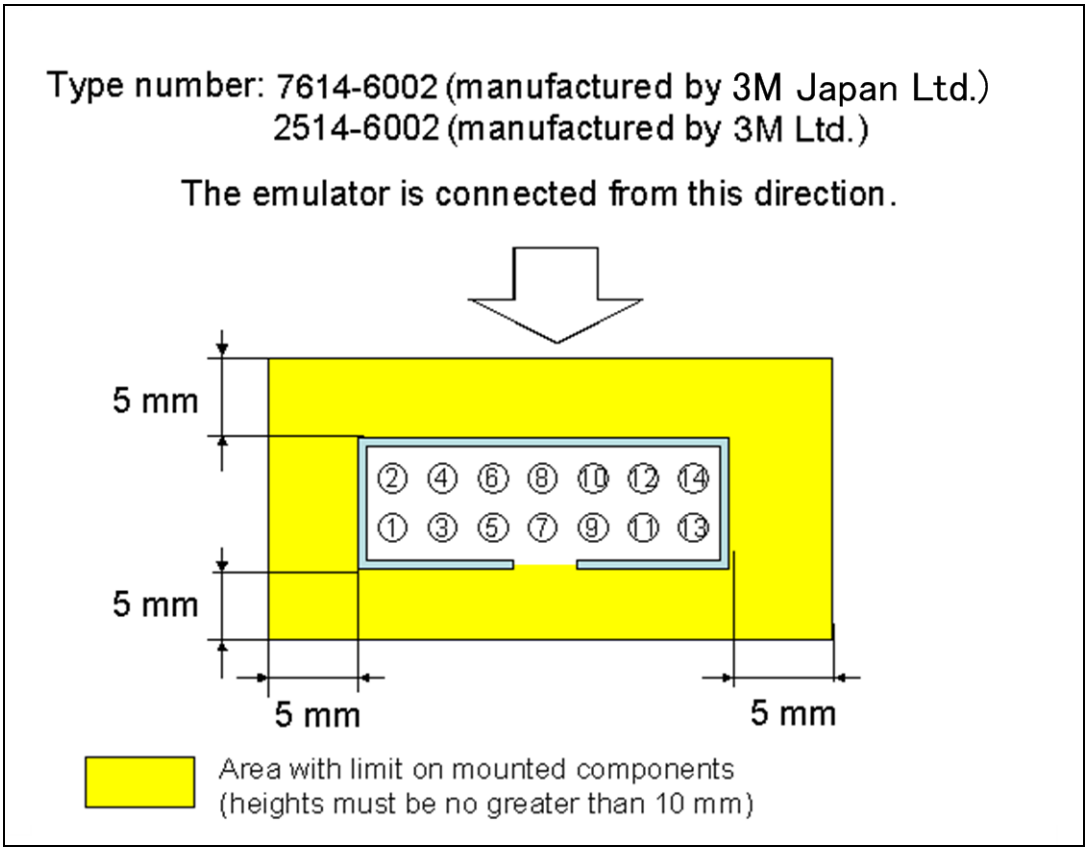


Figure 2-2 Connecting the User System Interface Cable to the 14-Pin Connector of the E20 Emulator

CAUTION

Limit to the height on connector periphery:

For a case where the R0E000200CKA00 is used for connecting the E20 to a 14-pin connector, do not mount other components with a height of 10 mm or more within 5 mm of the connector on the user system.

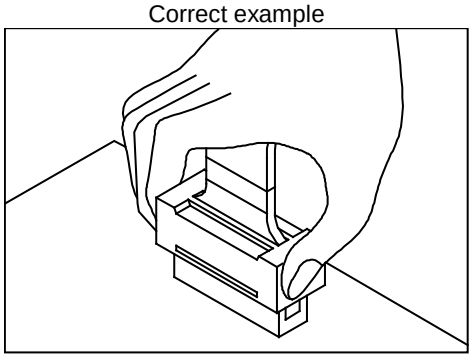


CAUTION

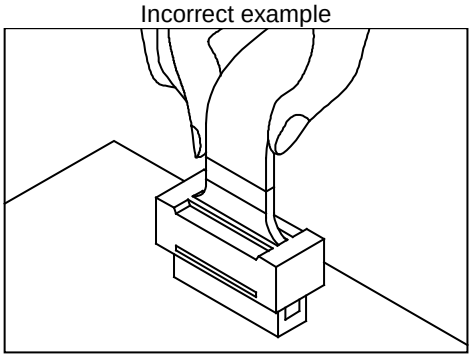
Notes on connector insertion and removal:

When connecting or disconnecting the user-system interface cable and the emulator or user system, grasp the connector cover at the end of the cable. Pulling the cable itself will damage the wiring.
Also, be aware that the user system interface cable has the direction in which it must be inserted. If the cable is connected in the wrong direction, it may be damaged.

Correct example



Incorrect example



2.3. Pin Assignments of the Connector on the User System

2.3.1. 14-Pin Connector Specifications

Figure 2-3 shows the specifications of the 14-pin connector.
Table 2-2 on the following pages shows the pin assignments of the 14-pin connector.

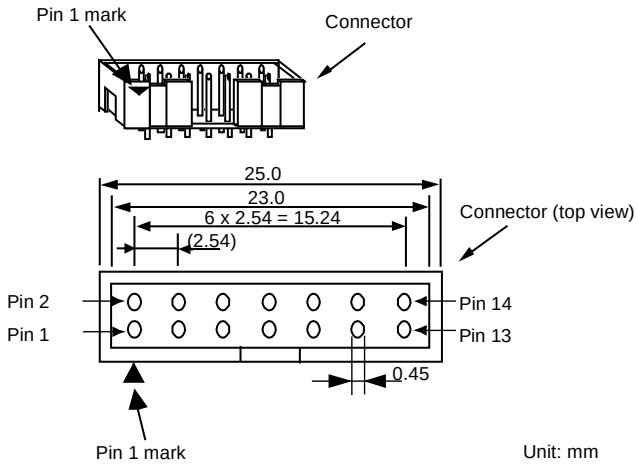


Figure 2-3 Emulator Connector Specifications (14 Pins)

Table 2-2 14-Pin Connector Pin Assignments

Pin No	Other than the 20-pin and 24-pin versions of RL78/G12		20-pin and 24-pin versions of RL78/G12		Note
	Signal *1 *2	Direction *3	Signal *1 *2	Direction *3	
1	R.F.U *6	—	R.F.U *6	—	
2	GND *4	—	GND *4	—	
3	R.F.U *6	—	R.F.U *6	—	
4	R.F.U *6	—	RSTPU	Input	This pin is used to pull up the reset line. (Only when selecting the 20-pin or 24-pin version of the RL78/G12.)
5	TOOL0	I/O	TOOL0	I/O	This pin is used to transmit command/data to the target device
6	RESET_IN	Output	RESET_IN	Output	This pin is used to input reset signal from the user system
7	R.F.U *6	—	R.F.U *6	—	
8	VDD	—	VDD	—	
9	EMVDD *7	—	EMVDD *7	—	
10	RESET_OUT *5	Input	RESET_OUT *5	Input	This pin is used to output reset signal to the target device
11	R.F.U *6	—	R.F.U *6	—	
12	GND *4	—	GND *4	—	
13	RESET_OUT *5	Input	RESET_OUT *5	Input	This pin is used to output reset signal to the target device
14	GND *4	—	GND *4	—	

*1 For details on the programming software, refer to
http://www.renesas.com/products/tools/flash_prom_programming/

*2 These are the names of the MCU pins at the time the E1/E20/E2 Lite is connected (i.e. during debugging).

*3 Input to or output from the user system.

*4 Securely connect pins 2, 12, and 14 of the connector to GND of the user system. These pins are used for electrical grounding as well as for monitoring of connection with the user system by the E1/E20/E2 Lite.

*5 Securely connect both pin 10 and pin 13.

*6 This pin is reserved. Perform the open processing.

*7 Connect the drive power of the TOOL0 pin.
Please connect VDD when the MCU doesn't have power supplies other than VDD such as EVDD.
The E2 Lite only supports a single power supply. If you are using an MCU that requires two or more power supplies with the E2 Lite, use a power supply other than VDD, such as EVDD, which has the same voltage as VDD.

2.4. Recommended Circuit between the Connector and the MCU

This section shows recommended circuits for connection between the connector and the MCU when the E1/E20/E2 Lite is in use. For processing of signals, refer to section 2.5, Notes on Connection.

2.4.1. Connection between the 14-Pin Connector and the RL78 Family MCUs (Except for the 20-Pin and 24-Pin Versions of the RL78/G12).

Figure 2-4 shows a recommended circuit for connection between the 14-pin connector and the RL78 family MCUs (except for the 20-pin and 24-pin versions of the RL78/G12).

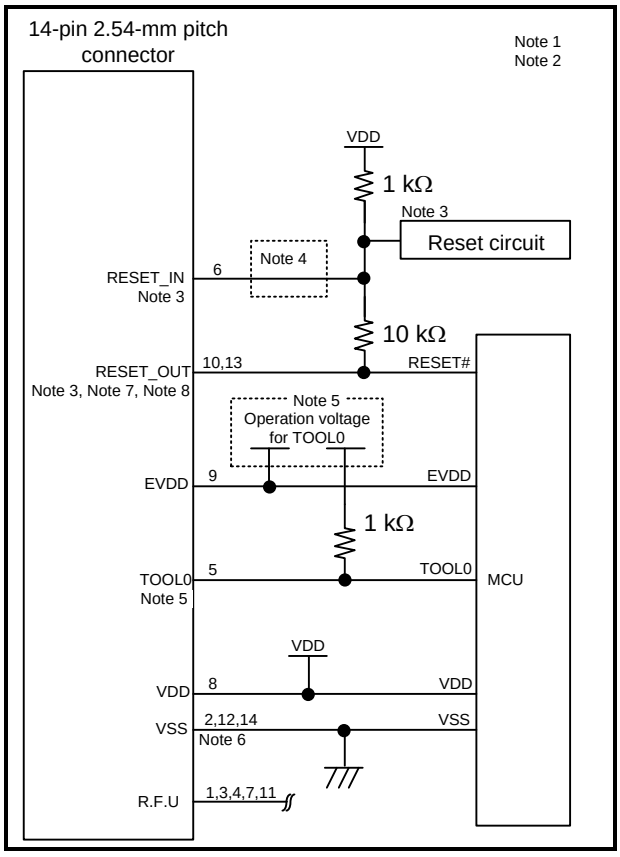


Figure 2-4 Example of Connection between the 14-Pin Connector and the RL78 Family MCUs (Except for the 20-Pin and 24-Pin Versions of RL78/G12).

Notes:
1. The circuits and resistance values listed are recommended but not guaranteed. Determine the circuit design and resistance values by taking into account the specifications of the target device and noise. For flash programming for mass production, perform sufficient evaluation about whether the specifications of the target device are satisfied.
2. For processing of pins not used by the E1/E20/E2 Lite, refer to the user's manual of the device.
3. For details on how to handle the RESET# pin, refer to section 2.5, Notes on Connection.
4. The RESET_IN pin is used only in debugging. It is not necessary in flash programming by the programming software.
5. The drive power supply of TOOL0 is different depending on devices. Defer to user's manual of device. Please connect VDD when the MCU doesn't have power supplies other than VDD such as EVDD.
6. Securely connect pins 2, 12, and 14 of the connection to GND of the user system. These pins are used for electrical grounding as well as for monitoring of connection with the user system by the E1/E20/E2 Lite.
7. Securely connect both pin 10 and pin 13.
8. When you use hot plug-in, install a ceramic capacitor (approx. 0.1 µF) between the RESET# pin and GND in order to suppress a noise to the RESET# pin that would occur when the emulator is connected.

2.4.2. Connection between the 14-Pin Connector and the RL78 Family MCUs (Only the 20-Pin and 24-Pin Versions of the RL78/G12).

Figure 2-5 shows a recommended circuit for connection between the 14-pin connector and the RL78 family MCUs (only the 20-pin and 24-pin version of the RL78/G12).

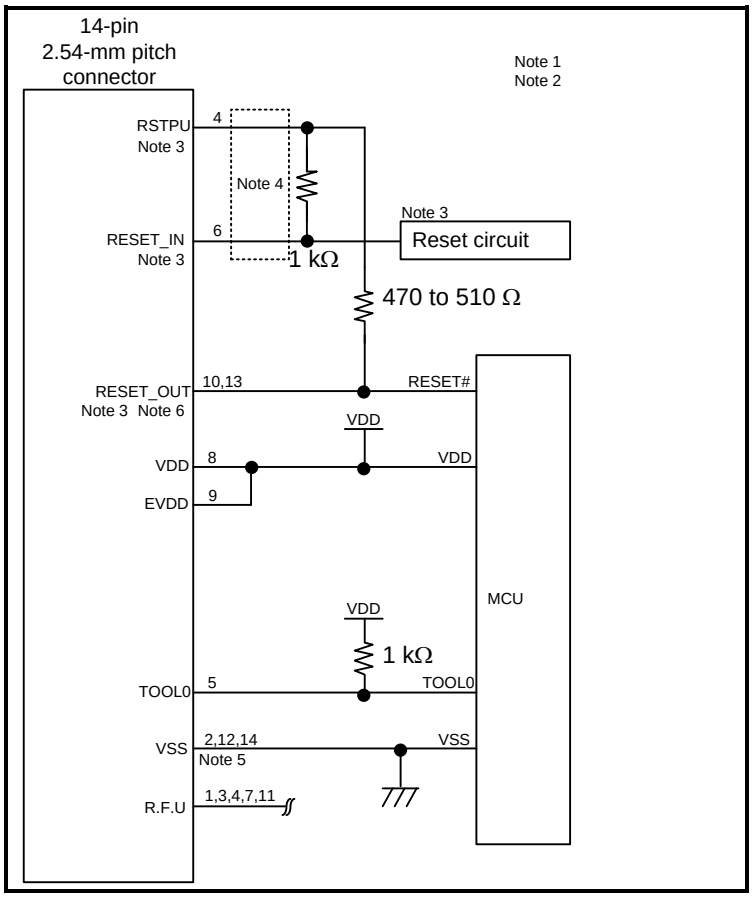


Figure 2-5 Example of Connection between the 14-Pin Connector and the RL78 Family MCUs (Only the 20-Pin and 24-Pin Versions of the RL78/G12).

Notes:	1	The circuits and resistance values listed are recommended but not guaranteed. Determine the circuit design and resistance values by taking into account the specifications of the target device and noise. For flash programming for mass production, perform sufficient evaluation about whether the specifications of the target device are satisfied.
	2	For processing of pins not used by the E1/E20/E2 Lite, refer to the hardware manual for the device.
	3	The recommended circuit for the RESET# pin differs depending on whether the multiplexed functions are used. For details on how to handle the RESET# pin, also refer to section 2.5, Notes on Connection.
	4	The RESET_IN pin is used only in debugging. It is not necessary in flash programming by the programming software.
	5	Securely connect pins 2, 12, and 14 of the connection to GND of the user system. These pins are used for electrical grounding as well as for monitoring of connection with the user system by the E1/E20/E2 Lite.
	6	Securely connect both pin 10 and pin 13.

2.5. Notes on Connection

Wiring patterns between the connector and the MCU must be as short as possible (within 50 mm is recommended). Do not connect the signal lines between the connector and MCU to other signal lines on the board.
For the handling of pins while the E1/E20/E2 Lite is not in use, refer to the hardware manual for the MCU.

2.5.1. RESET# Pin

The RESET# pin is used by the E1/E20/E2 Lite to monitor the pin state and issue a reset to the device. Therefore, a reset signal on the user system is once input to the E1/E20/E2 Lite where it is controlled by masking and then output to the target device. Connection examples of the RESET# pin section are shown in Table 2-3 and Figure 2-6 to Figure 2-10.
When flash programming by the programming software is to be performed, the RESET# pin should be designed so that the reset signal on the user system does not conflict with the reset signal from the E1/E20/E2 Lite.

When you use hot plug-in, install a ceramic capacitor (approx. 0.1 µF) between the RESET# pin and GND in order to suppress a noise to the RESET# pin that would occur when the emulator is connected. Hot plug-ins are not available if there is no reset circuit.

Table 2-3 Connection Examples According to the Reset Circuit on the User System

No	Target Device	Case	Reference
1	20-pin and 24-pin versions of the RL78/G12	There is a reset circuit on the user system.	Figure 2-6
2		There is no reset circuit on the user system. (when using the P125/KR1/SI01 function which is multiplexed with RESET#)	Figure 2-7
3	Other than above	There is a reset circuit on the user system. (Resistors are used to switch between usage and non-usage of the emulator)	Figure 2-8
4		There is a reset circuit on the user system. (A jumper is used to switch between usage and non-usage of the emulator)	Figure 2-9
5		The power-on reset circuit is the only reset circuit on the user system.	Figure 2-10

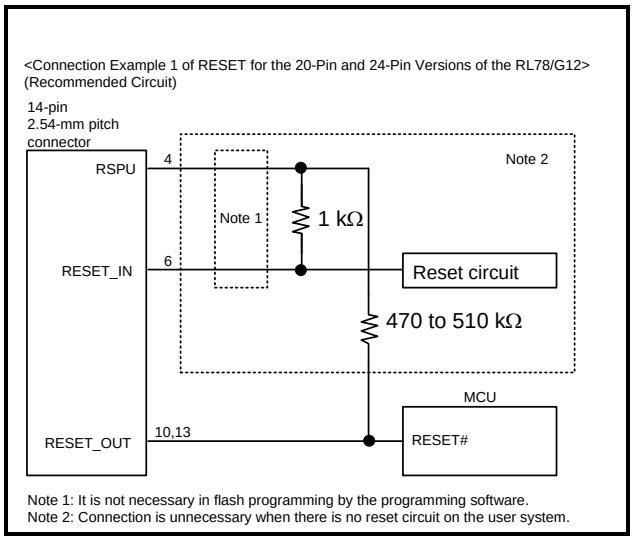


Figure 2-6 Connection Example 1 of RESET#
(Only the 20-Pin and 24-Pin Versions of the RL78/G12)

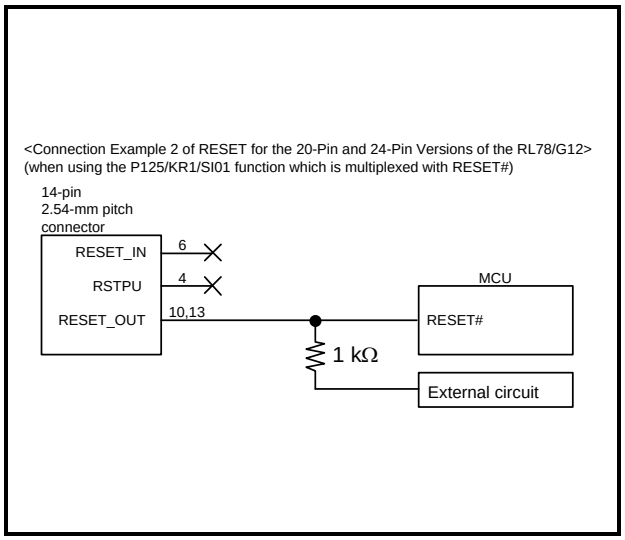


Figure 2-7 Connection Example 2 of RESET#
(Only the 20-Pin and 24-Pin Versions of the RL78/G12)

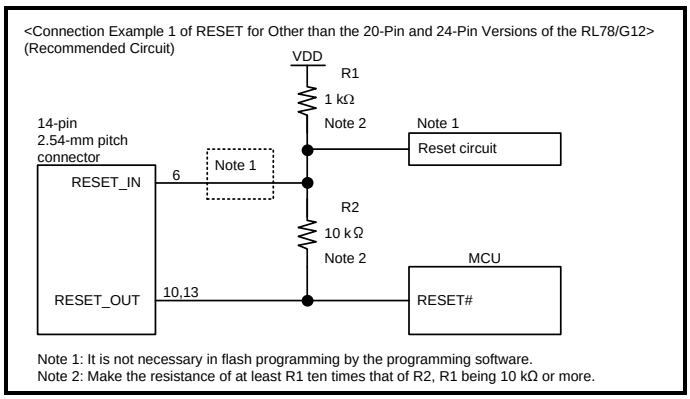


Figure 2-8 Connection Example 1 of RESET#
(Other than the 20-Pin and 24-Pin Versions of the RL78/G12)

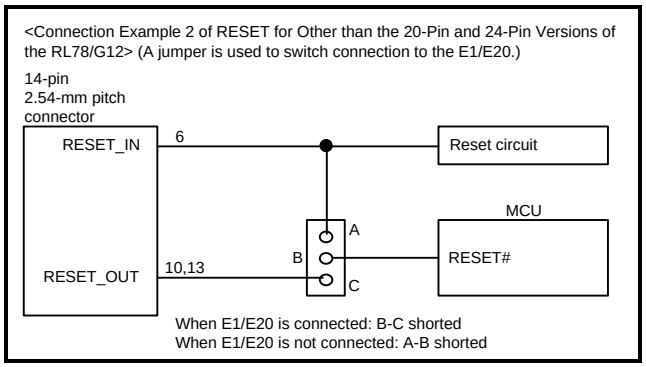


Figure 2-9 Connection Example 2 of RESET#
(Other than the 20-Pin and 24-Pin Versions of the RL78/G12)

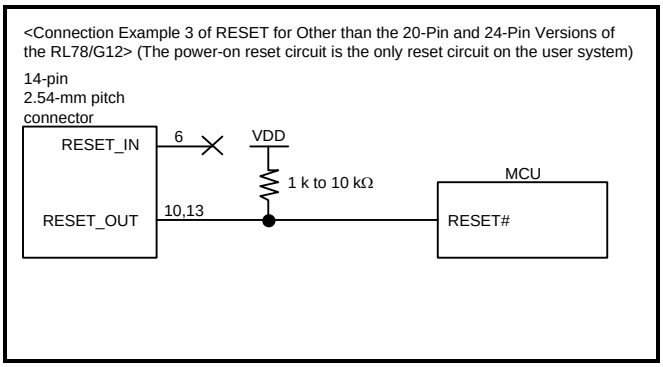


Figure 2-10 Connection Example 3 of RESET#
(Other than the 20-Pin and 24-Pin Versions of the RL78/G12)

- Do not install capacitors, series resistors, or filters on signal lines; if attempted, correct communication may not be established.
- The circuits and resistance values listed are recommended but not guaranteed. Determine the circuit design and resistance values by taking into account the specifications of the target device and noise.
- Securely connect pins 2, 12, and 14 to GND of the user system. These pins are used for electrical grounding as well as for monitoring of connection with the user system by the E1/E20/E2 Lite.
- Securely connect both pin 10 and pin 13.

2.5.2. TOOL0 Pin

The E1/E20/E2 Lite uses the TOOL0 pin. Any functions that are multiplexed on this pin are not available. Pull up the signals of the TOOL0 pin at 1 kΩ and do not arrange these signal lines in parallel with or across other high-speed signal lines.

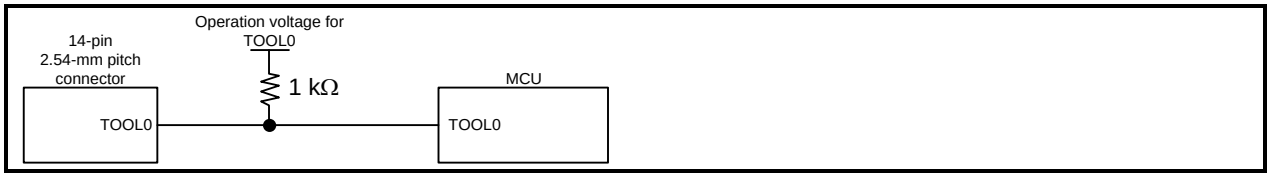


Figure 2-11 Connection Example of the TOOL0 Pin

Do not use adjacent resistors for pull-up of the TCK pin because they may affect or may be affected from other pins.
Do not install capacitors, series resistors, or filters on signal lines; if attempted, correct communication may not be established.

2.5.3. GND

The pins of the connector marked "GND" must be at the same ground level as the VSS pin of the MCU.

2.5.4. VDD

Connect the VDD of the connector to the VDD (power supply) of the user system.
Use the emulator within the power supply voltage of 1.8 V to 5.5 V and within the operating voltage range of the MCU.
When power is supplied to the user system from other than the emulator, the E1/E20/E2 Lite consumes the power supply for the last output and first input buffers of the emulator.

E1:	3.3 V: approximately 20 mA,	5.0 V: approximately 40 mA
E20:	3.3 V: approximately 40 mA,	5.0 V: approximately 100 mA
E2 Lite:	3.3 V: approximately 20 mA,	5.0 V: approximately 40 mA

The E1/E2 Lite can supply power to a simple evaluation system.

E1: Can supply power of 3.3 V or 5.0 V, up to 200 mA.
E2 Lite: Can supply power of 3.3 V, up to 200 mA.

When using the power supply function of the E1/E2 Lite, check the voltage supplied to the user system. Particularly, when the 5.0-V supply option is selected, the voltage may drop 0.5 V or more since it depends on the USB VBUS power-supply voltage.

The on-chip debugging circuit in the device operates during on-chip debugging. Therefore current consumption of the device increases. When evaluating current consumption of the device, do not connect the E1/E20/E2 Lite.

Power supply from the E1/E2 Lite depends on the quality of the USB power supply of the host machine, and as such, precision is not guaranteed. When writing a program that requires reliability, do not use the power supply function of the E1/E2 Lite. Use a stable, separate power supply for the user system. When writing a program for mass production processes, use the Renesas Flash Programmer.
For details on the programming software, refer to:
http://www.renesas.com/products/tools/flash_prom_programming/ .

WARNING

Warning for Turning the Power On/Off:

When supplying power, ensure that there are no shorts between VDD and GND. Only connect the E1/E20/E2 Lite after confirming that there are no mismatches of alignment on the user system port connector. Incorrect connection will result in the host machine, the E1/E20/E2 Lite, and the user system emitting smoke or catching fire.

2.6. Internal Circuits of the Emulator

2.6.1. Internal Circuits of the E1 (when the RL78 Family is Connected)

Figure 2-12 shows the internal circuits of the E1 with the RL78 family connected.

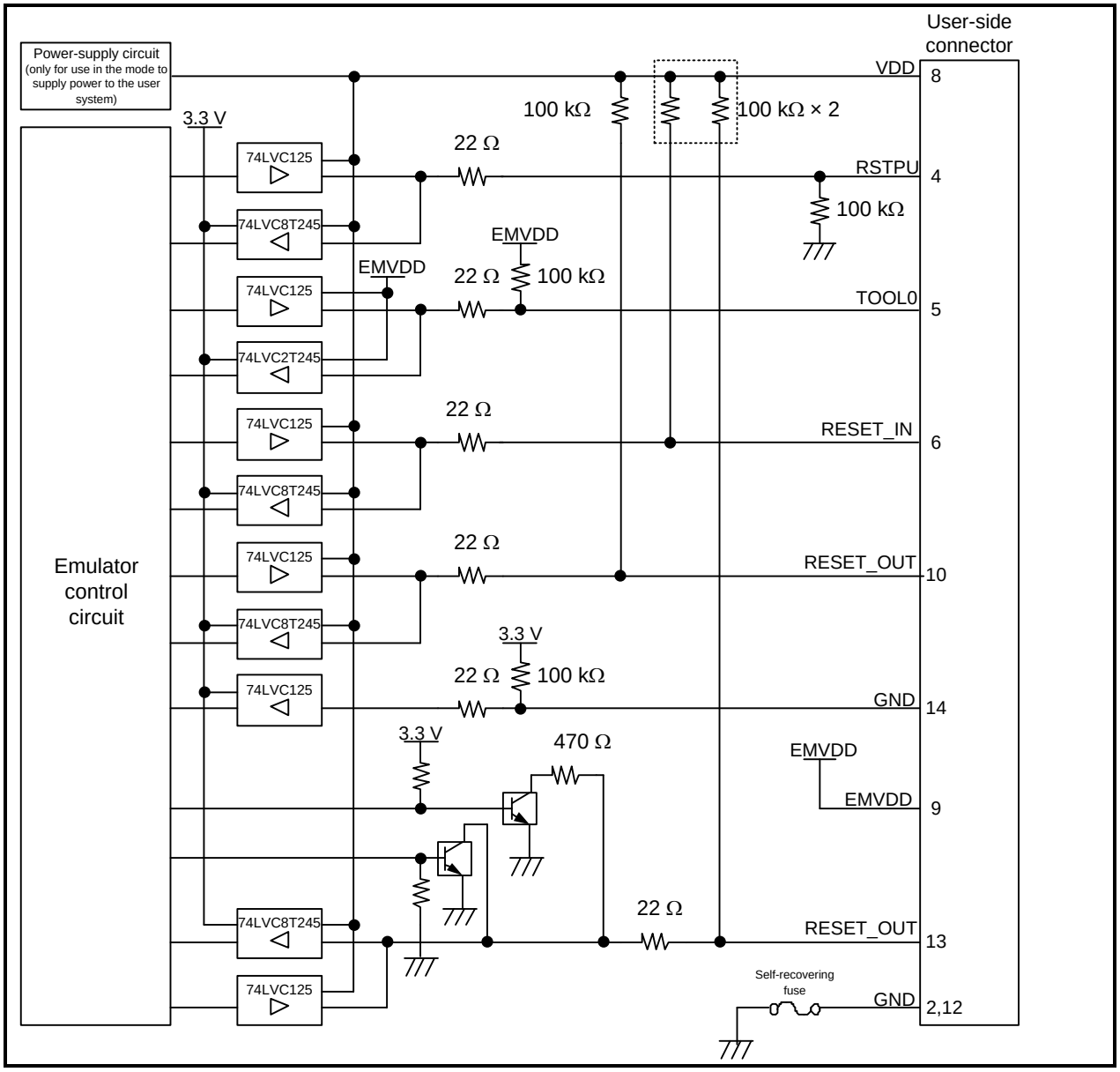


Figure 2-12 Internal Circuit of the E1 (when the RL78 Family is Connected)

2.6.2. Internal Circuits of the E20 (when the RL78 Family is Connected)

Figure 2-13 shows the internal circuits of the E20 with the RL78 family connected.

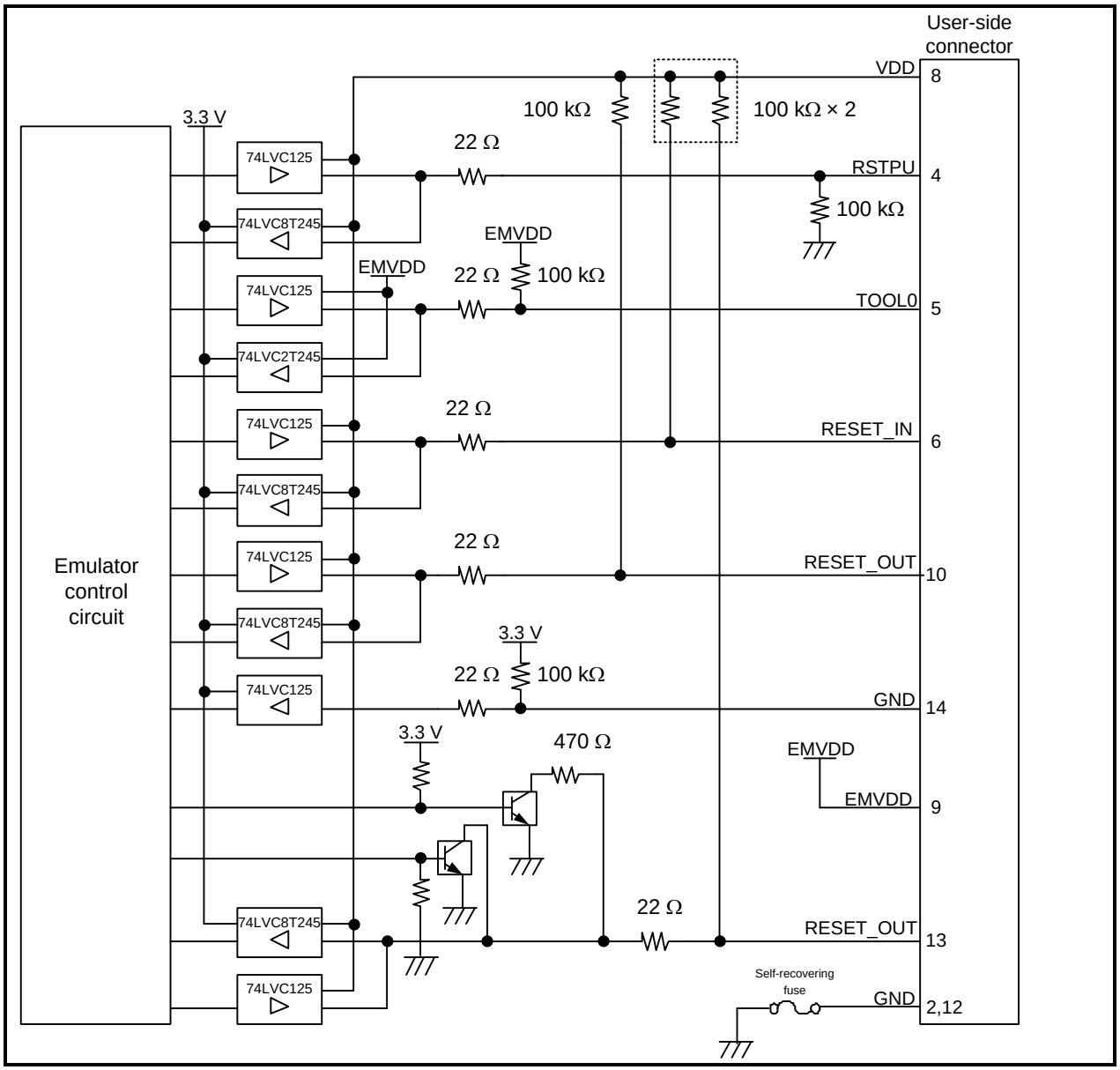


Figure 2-13 Internal Circuits of the E20 (RL78 Family)

2.6.3. Internal Circuits of the E2 Lite (when the RL78 Family is Connected)

Figure 2-14 shows the internal circuits of the E2 Lite with the RL78 family connected.

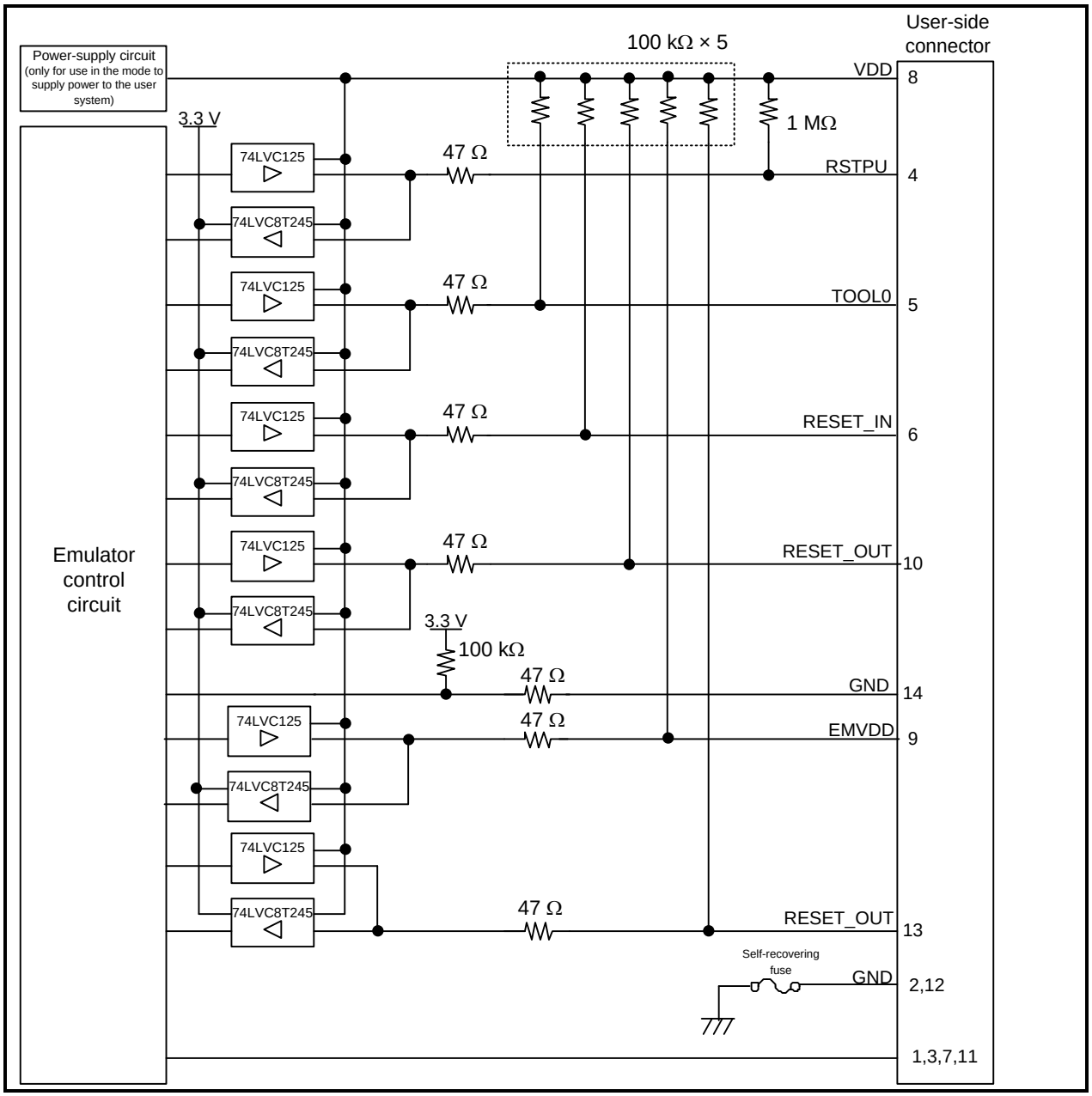


Figure 2-14 Internal Circuits of the E2 Lite (when the RL78 Family is Connected)

2.7. Notes on Designing the User System

2.7.1. Isolators for the E1 and E20

For a debugging environment where there is a difference in potential between the GND of the user system and that of the host PC, use the isolator for the E1 emulator (R0E000010ACB20) which is separately available from Renesas.
That is, use the isolator for the E1 (R0E000010ACB20) with the E2 Lite in such situations.

2.7.2. Small Connector Conversion Adapter for the E1

A small connector conversion adapter for the E1 (R0E000010CKZ11) is separately available from Renesas for user system boards which are too small to mount the 14-pin connector that is the standard connector for the E1 and E2 Lite. By using the adapter, you can reduce the area taken up by the connector mounted on your system.
However, when you use the small connector conversion adapter for the E1, be aware that the pin assignments of the connector differ from those of the standard interface connector for the E1 and E2 Lite. The pin assignments on the 14-pin connector when the small connector conversion adapter for the E1 is used are shown in Table 2-4.
The small connector conversion adapter for the E1 can also be used with the E2 Lite.

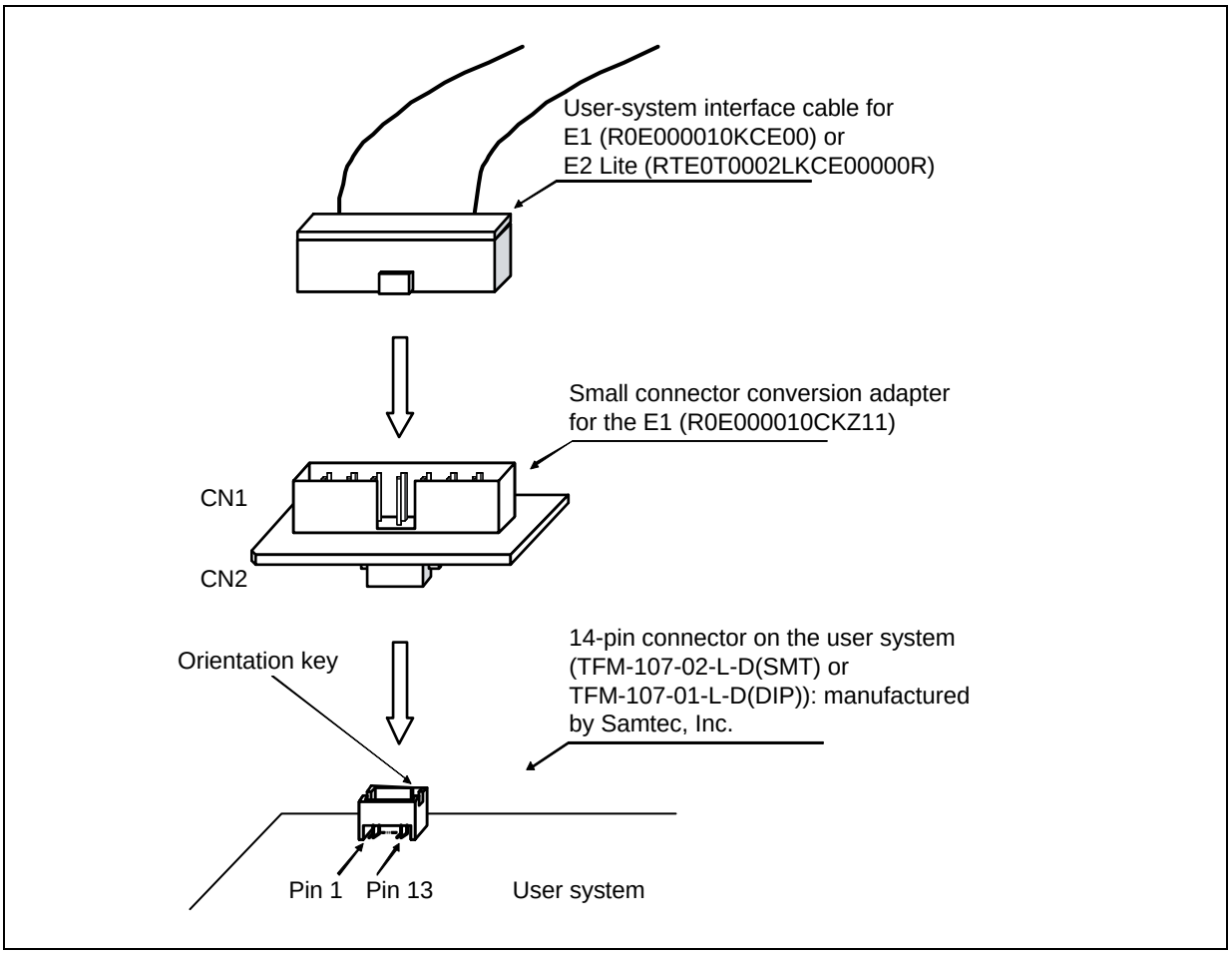


Figure 2-15 Usage of the Small Connector Conversion Adapter for the E1

Table 2-4 Connector Pin Assignments when the Small Connector Conversion Adapter for the E1 is Used

Pin No.	Other than the 20-pin and 24-pin versions of RL78/G12		20-pin and 24-pin versions of RL78/G12		Note
	Signal *1 *2	Direction *3	Signal *1 *2	Direction *3	
1	GND *4	–	GND *4	–	
2	R.F.U *6	–	R.F.U *6	–	
3	VDD	–	VDD	–	
4	R.F.U *6	–	R.F.U *6	–	
5	RESET_OUT *5	Input	RESET_OUT *5	Input	This pin is used to output reset signal to the target device
6	GND *4	–	GND *4	–	
7	RESET_OUT *5	Input	RESET_OUT *5	Input	This pin is used to output reset signal to the target device
8	R.F.U *6	–	R.F.U *6	–	
9	R.F.U *6	–	R.F.U *6	–	
10	TOOL0	I/O	TOOL0	I/O	This pin is used to transmit command/data to the target device
11	R.F.U *6	–	RSTPU	Input	This pin is used to pull up the reset line. (Only when selecting the 20-pin and 24-pin version of the RL78/G12.)
12	RESET_IN	Output	RESET_IN	Output	This pin is used to input reset signal from the user system
13	EMVDD *7	–	EMVDD *7	–	
14	GND *4	–	GND *4	–	

*1 For details on the programming software, refer to:
http://www.renesas.com/products/tools/flash_prom_programming/

*2 These are the names of the MCU pins at the time the E1/E20/E2 Lite is connected (i.e. during debugging).

*3 Input to or output from the user system.

*4 Securely connect pins 1, 6, and 14 of the connector to GND of the user system. These pins are used for electrical grounding as well as for monitoring of connection with the user system by the E1/E20/E2 Lite.

*5 Securely connect both pin 5 and pin 7.

*6 This pin is reserved. Perform the open processing.

*7 Connect the drive power of the TOOL0 pin.
Please connect VDD when the MCU doesn't have power supplies other than VDD such as EVDD.
The E2 Lite only supports a single power supply. If you are using an MCU that requires two or more power supplies with the E2 Lite, use a power supply other than VDD, such as EVDD, which has the same voltage as VDD.

3. Notes on Usage

3.1. Turning the Power On/Off

Turn the power of the E1/E20/E2 Lite and the user system following the procedure below.

3.1.1. When a Separate Power Supply is Used for the User System

<When using the emulator>

(1) Check that the power is off.
Check that the user system is turned off. When using the E20, check its power switch is off.

(2) Connect the user system.
Connect the emulator and the user system with a user-system interface cable.

(3) Connect the host machine and turn on the emulator.
Connect the emulator and the host machine with a USB interface cable. The E1/E2 Lite is turned on by connecting the USB interface cable. When using the E20, turn on its power switch.

(4) Launch the emulator debugger or programming software.
Launch the emulator debugger or programming software.

(5) Turn on the user system.
Turn on the user system.

(6) Launch the emulator debugger or connect the programming software to the emulator.
Connections may vary depending on software.

<When finished using the emulator>

(1) Close the emulator debugger or disconnect the emulator from the programming software.
Disconnections may vary depending on software.

(2) Turn off the user system.
Turn off the user system.

(3) Close the emulator debugger or the programming software.
Close the emulator debugger or the programming software.

(4) Turn off the emulator and disconnect the emulator.
When using the E20, turn off its power switch. Disconnect the USB interface cable from the E1/E2 Lite. The E1/E2 Lite is turned off by disconnecting from the USB interface cable.

(5) Disconnect the user system.
Disconnect the user system interface cable from the user system.

CAUTION

Notes on the User System Power Supply:

While the power of the user system is on, do not turn off the host machine, unplug the USB interface cable, or turn off the power switch of the E20.
The user system may be damaged due to leakages current.

3.1.2. When Power is Supplied to the User System from the Emulator (E1/E2 Lite Only)

<When using the emulator>

(1) Connect the user system.
Connect the emulator and the user system with a user-system interface cable.

(2) Connect the host machine and turn on the emulator.
Connect the emulator and the host machine with a USB interface cable, then turn on the emulator.

(3) Launch the emulator debugger or programming software.
Launch the emulator debugger or programming software and select the setting of power supply to the user system.

(4) Connect the emulator debugger or programming software to the emulator.
Connections may vary depending on software.

<When finished using the emulator>

(1) Disconnect the emulator debugger or programming software from the emulator.
Disconnections may vary depending on software.

(2) Close the emulator debugger or programming software.
Close the emulator debugger or programming software.

(3) Turn off the emulator and disconnect the emulator.
Disconnect the USB interface cable from the emulator, then turn off the emulator.

(4) Disconnect the user system.
Disconnect the user system interface cable from the user system.

3.2. Power Supply Function of the E1/E2 Lite

When using the power supply function of the E1/E2 Lite, check that the voltage is supplied to the user system. Particularly, when the 5.0-V supply option is selected, the voltage may drop 0.5 V or more since it depends on the USB VBUS power-supply voltage. Note that the E2 Lite supports power supply of 3.3 V only.

When debugging a system with two power supplies (VDD, EVDD, etc.) to the MCU, power cannot be supplied from the E1/E2 Lite.

3.3. MCU Resources to be Occupied

Figure 3-1 shows the areas which are occupied by the E1/E20/E2 Lite for debugging.
These areas (shaded sections) are used for debugging. These areas should not be changed to save the user program or data. If a change is made, control by the E1/E20/E2 Lite is no longer possible.

However, when "No" is selected in the [Permit flash programming] property of the debugger, the internal ROM spaces shown in Figure 3-1 and Figure 3-2 are not used (only the internal RAM spaces are used). When selecting not to permit flash memory rewriting with the debugger's property, also refer to section 3.3.3, Setting of On-Chip Debugging Option Byte, and section 3.5.2, Operation for Voltages and Flash Operation Modes Not Permitting Flash Memory Rewriting.

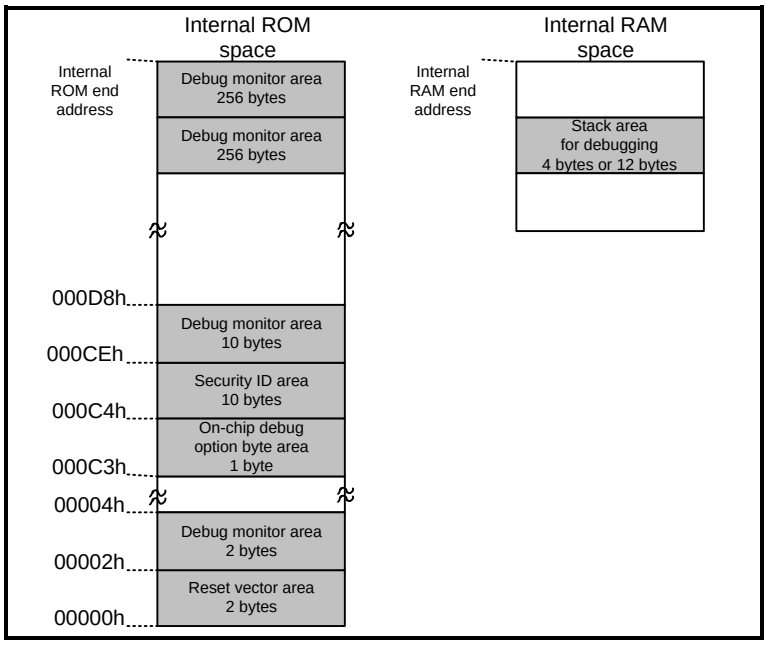


Figure 3-1 MCU Resources to be Occupied (E1/E20)

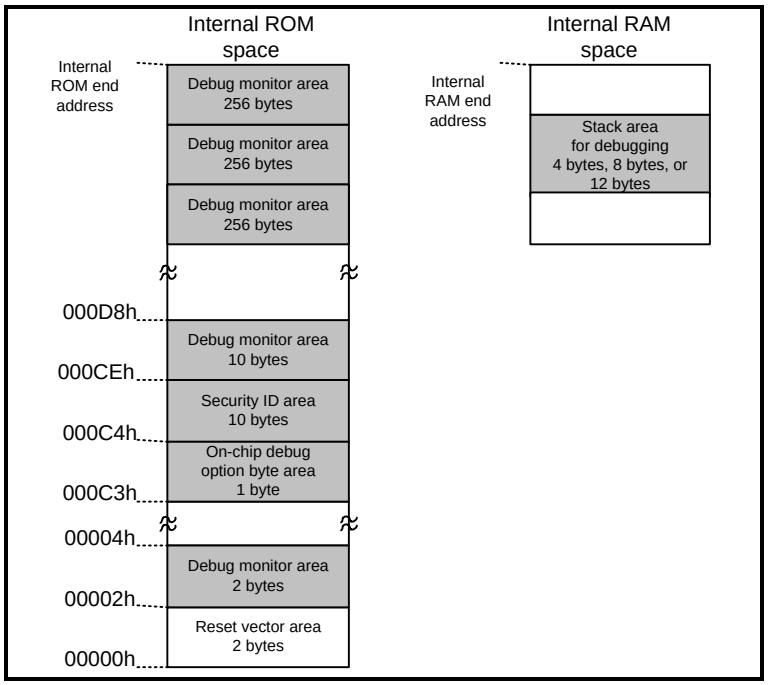


Figure 3-2 MCU Resources to be Occupied (E2 Lite)

*1 The reset vector area is used by the program for the E1/E20/E2 Lite when performing debugging with the E1/E20/E2 Lite. If the contents of the reset vector area are changed, control by the E1/E20/E2 Lite is no longer possible.

3.3.1. Securing an Area for the Debugging Monitor Program

You may need to secure the area to which the debugging monitor program is to be allocated. The monitor program initializes the debugger communications interface and handles processing to make the CPU run or break execution.

The user program or data must not be placed within 23 bytes of the on-chip debugging option byte, and leave an area of at least 768 bytes[Note1] before the address where the internal ROM area ends.

In addition, the reset vector must be changed if it points to an address to which the monitor program is allocated.

[Securing the area]

Specifically securing the area for the monitor program is not necessarily required if the user program does not use the area.
However, to avoid problems that may occur while the debugger is starting up, we recommend securing this area in advance by using a build tool or some other means.

Note: 1 The required area differs according to the state of usage of the pseudo-RRM/DMM function or the start/stop facility (only the E2 Lite supports the latter).
Example (device with 256 Kbytes of on-chip ROM)

Pseudo-RRM/DMM function and start/stop function are not in use:
Monitor program is located at addresses 0x3FF00 to 0x3FFFF (256 bytes).
Pseudo-RRM/DMM function or start/stop function is in use:
Monitor program is located at addresses 0x3FE00 to 0x3FFFF (512 bytes).
Pseudo-RRM/DMM function and start/stop function are in use:
Monitor program is located at addresses 0x3FD00 to 0x3FFFF (768 bytes).

3.3.2. Securing a Stack Area for Debugging

The debugger requires 4 bytes as a stack area for debugging except if start/stop functions (only supported by the E2 Lite) are in use, in which case the size of the stack area for debugging is up to 8 bytes. Since this area is allocated immediately below the main stack area, the address of this area varies with increases and decreases in the stack size. That is, if a program is using none of the stack (the stack is empty), the 4- or 8-byte stack area for the debugger remains.

Make sure the stack area for debugging does not go beyond the range of the internal RAM space.[Note1]

Figure 3-3 and Figure 3-4 show examples in which the stack area has increased with the start address of the internal RAM space being 0xFCF00.

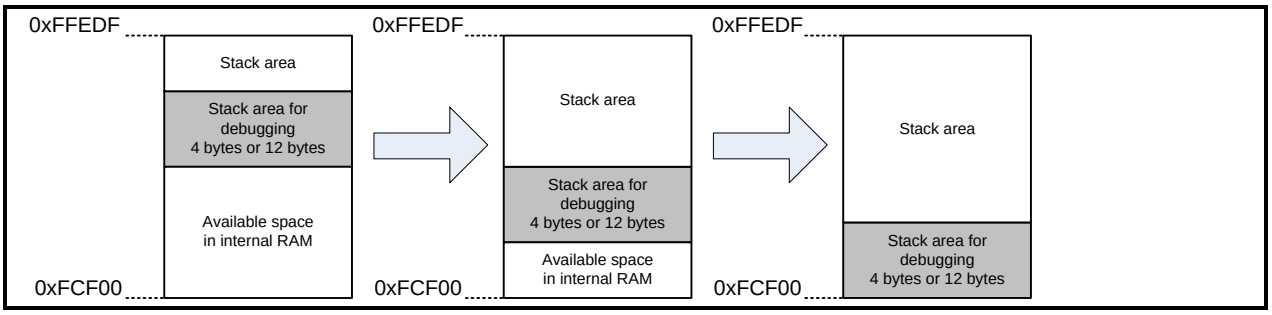


Figure 3-3 Variation of Address of Stack Area for Debugging (E1/E20)

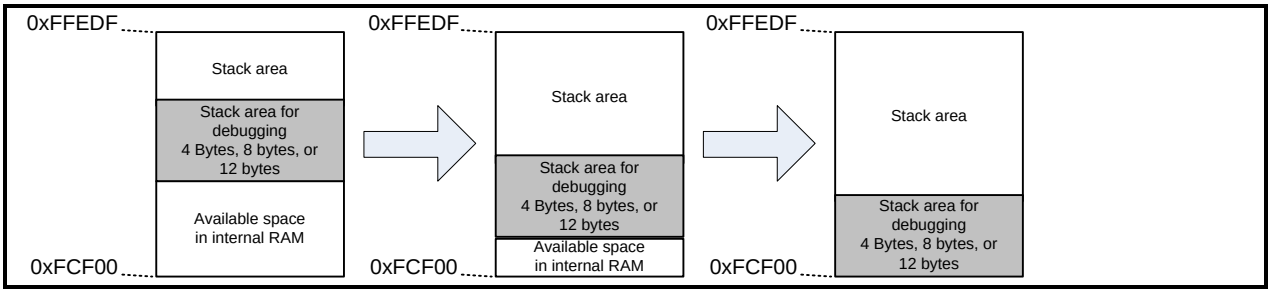


Figure 3-4 Variation of Address of Stack Area for Debugging (E2 Lite)

Note: 1 During self-programming, the size of the stack area for debugging is up to 12 bytes. Refer to the self-programming manual for how to secure the stack area for self programming. The start/stop function is disabled for self-programming, so is irrelevant to the size of the stack area for debugging.

3.3.3. Setting an On-Chip Debugging Option Byte

This is the area for the security setting to prevent the flash memory from being read by an unauthorized person.
For settable values, refer to the user's manual for each MCU.

[Setting an on-chip debugging option byte] *1
Set the on-chip debugging option byte in either of the following ways.

(a) Embed the on-chip debugging option byte at address 0xC3 in the user program.
Embed the on-chip debugging option byte at address 0xC3 in the user program.

(b) Set the on-chip debugging option byte by the build tool.
For details on the setting method, refer to the user's manual for the build tool.

*1 If the value of the on-chip debugging option byte set in the device disables on-chip debugging (OCDENSET = 0), the debugger cannot be started when "No" is selected in the [Permit flash programming] property of the debugger. If a setting to enable flash programming is made, though the debugger can be started, the flash memory will be in an erased state when the debugger is started.

3.3.4. Setting a Security ID

This setting is required to prevent the memory from being read by an unauthorized person. Embed a security ID at addresses 0xC4 to 0xCD in the internal flash memory. The debugger starts only when the security ID that is set during debugger startup and the security ID set at addresses 0xC4 to 0xCD match. If the ID codes do not match, the debugger manipulates the target device in accordance with the value set to the on-chip debug option byte area (refer to the hardware manual for each MCU).

If the user has forgotten the security ID to enable debugging, erase the flash memory and set the security ID again.

Set the security ID in either of the following ways. When both methods (a) and (b) are carried out at the same time, method (b) has priority.

(a) Embed the security ID at addresses 0xC4 to 0xCD in the user program.
For example if the security ID is embedded as follows, the security ID set by the debugger is ″0123456789ABCDEF1234″ (not case-sensitive). Note1,Note2

(b) Set the security ID by common options of the build tool.
For details on the setting method, refer to the user's manual for the build tool.

Table 3-1 Example of Security ID Setting

Address	Value
0x000C4	0x01
0x000C5	0x23
0x000C6	0x45
0x000C7	0x67
0x000C8	0x89
0x000C9	0xAB
0x000CA	0xCD
0x000CB	0xEF
0x000CC	0x12
0x000CD	0x34

Notes: 1 When connecting a debugger to a device for which the security ID has been set, the security ID needs to be entered in the debugger. For details on the authentication method, refer to the user's manual for the debugger in use.
2 "0xFFFFFFFFFFFFFFFFFFFF" which is a setting of only "0xFF" cannot be set.

3.4. Reset

3.4.1. Operation after a Reset

After an external pin reset or internal reset, the monitor program performs debug initialization processing. Consequently, the time from reset occurrence until user program execution differs from that in the actual device operation. If “No” is selected in Permit flash programming in property of the debug tool, the time until the user program is executed compared with the time when “Yes” is selected is delayed by several 100 ms.

3.4.2. SP Value after a Reset

While debugging with the E1/E20/E2 Lite, the SP value after a reset becomes as follows:

- When the internal RAM space of the device is 768 bytes or more: FC00h
- When the internal RAM space of the device is less than 768 bytes:
  Start address of internal RAM + 0x20
  [Example] When the start address of internal RAM is 0xFEF00: 0xEF20

3.5. Flash Memory

3.5.1. Flash Memory Programming by Self-Programming

(1) Areas which cannot be rewritten by self programming
If a space where the debug monitor program is allocated is rewritten by flash self programming, the debugger can no longer operate normally. This caution also applies to boot swapping for such an area.

(2) Break occurring during self programming
Though breaks other than a forced break can be generated while self programming is in progress, step execution cannot be performed from where the break occurred. If a forced break occurs during self programming, control by the E1/E20/E2 Lite may not be possible.

3.5.2. Operation for Voltages and Flash Operation Modes Not Permitting Flash Memory Rewriting

When a voltage with which rewriting or erasure of flash memory cannot be performed has been selected or flash programming has been disabled with the debugger's property, the following debugger operations that accompany flash memory rewriting will cause an error in the debugger and the operations will be invalidated.

- Writing to internal flash memory
- Setting or canceling of software breakpoint
- Starting execution at the set software breakpoint position
- Step execution at the set software breakpoint position
- Step-over execution, Return Out execution
- Come Here
- Setting, changing, or canceling of hardware breaks
- Masking/unmasking of internal reset
- Switching of peripheral breaks

The operating frequency range and operating voltage range are set with the flash operation mode. Correct operation may not be carried out when the operating frequency range or operating voltage range is exceeded.

3.6. GDIDIS

The global digital input disable register (GDIDIS) which is used to prevent through-current flowing from the input buffers when the EVDD power supply is turned off (EVDD = 0 V) cannot be used in the E1/E20/E2 Lite. This is because the TOOL0 pin of the EVDD power supply cannot accept input when GDIDIS = 1 (Input to input buffers prohibited.) and so communication with the E1/E20/E2 Lite is broken.

3.7. RESET# Multiplexed Pin

In the 20-pin and 24-pin versions of the RL78/G12, the RESET# pin has multiplexed pin functions. Therefore, if the following conditions are all satisfied, control by the E1/E20/E2 Lite is no longer possible.

- The reset/port multiplexed pin is used as a port (PORTSELB = 0) due to the option byte setting (C1h).
- The option byte setting (C1h) has been rewritten during a break.
- "Yes" is selected in the [Mask INTERNAL RESET signal] property of the debugger.

3.8. MCUs that are Used in Debugging

3.8.1. Usage in Mass-Production

MCUs that are connected to the E1/E20/E2 Lite and used in debugging are placed under stress by repeated programming of flash memory during emulation. Do not use MCUs that were used in debugging in mass-production for end users.

Also, as the E1/E20/E2 Lite program is written to the MCU while debugging, do not save the contents of the MCU Flash memory which were used for debugging nor use them as the ROM data for products.

3.8.2. Standalone Operation

After downloading a load module file to the device to for on-chip debugging, do not check the operation of this device without E1/E20/E2 Lite.
A device after debugging contains the specific program for on-chip debugging, so it is different from actual operation.

3.9. Final Evaluation of the User Program

Before entering the mass-production phase, be sure to perform a final evaluation of the program which is written to a flash ROM by the Renesas Flash Programmer, PG-FP5, etc. Be sure to perform the evaluation singly, without the E1/E20/E2 Lite connected.

3.10. Debug Functions

3.10.1. Step Execution

(1) Cautions on using step-in (step execution)
The value of some SFRs (special function registers) might remain unchanged while stepping into code. If the values of the SFRs do not change while stepping into code, operate the microcontroller by continuously executing the instructions instead of executing them in steps.
Stepping into code: Instructions in the user-created program are executed one by one.
Continuous execution: The user-created program is executed from the current PC value.

(2) Step-in (step execution) of Division operation (target: device with multiplier and divider/multiply-accumulator).
When the instruction which sets (1) the bit 0 (DIVST) of Multiplication/Division control register (MDUC) is stepped, the division operation is not finished. The step execution of the division operation of C source file is not relevant.

(3) Illegal memory access detection
When the function to detect illegal memory accesses is enabled (IAWCTL.7 = 1), an internal reset will not occur even when step execution is performed for an instruction that will generate an illegal memory access.

3.10.2. [Go to Here]

If [Go to Here] is selected, the software breakpoints and event breakpoints that have been set so far will be temporarily invalidated.

3.10.3. Debugging in Standby Mode

The break is an interrupt function of the CPU. Standby mode is released by the break generated by using the following debugging functions.

<1> Forced break
<2> Step execution of the standby instruction (Stops the user program after execution instruction)
<3> Short break generated by the pseudo-RRM function (Break When Readout)
<4> Short break generated by the pseudo-DMM function (Break When Write)
<5> Short break generated by setting a breakpoint while executing the user program

3.10.4. Pseudo-Real-Time RAM Monitor Function or Pseudo-Dynamic Memory Modification Function

Note the following points when using the pseudo-real-time RAM monitor (RMM) function or the pseudo-Dynamic Memory Modification (DMM) function.

- Standby mode (HALT or STOP) may be cancelled during monitoring.
- The pseudo-RRM function or the pseudo-DMM function does not operate while the CPU operating clock is stopped.
- When the number of monitoring points is numerous, the response of the debugger becomes slow.
- Influence of the debugger response becomes small by using a watch panel instead of a memory panel.
- When operating on the sub clock, neither the pseudo-RRM function nor the pseudo-DMM function will operate.
- Even when the RAM guard function is enabled, memory contents can be rewritten by the pseudo-DMM function.

3.10.5. Start/Stop Functions Facility

The E1 and E20 do not have a “start/stop” functions (routines) facility but the E2 Lite does. Note the following points if you intend to use this facility.

- Even if the start/stop routines write new values to the CPU registers, the states of the registers are restored at the ends of the routines.
- Stepped execution of the start/stop routines is not possible. However, every time stepping over of CALL instructions and so on are internally run, the start/stop routine is enabled.
- Breaks cannot be used in start/stop routines.
- When execution of a user program starts from an address where a software breakpoint has been set, the instruction at the breakpoint is executed, then the start routine is run. The order of execution is (a), (b), and (c) below.

(a) Stepped execution (due to the break) of the instruction where the breakpoint is set
(b) Running the start routine
(c) Executing instructions of the user program following the first address, where the breakpoint is set (continuous execution except in cases of breakpoints or stepped execution)

- When execution of the user program starts from an address at which an event break condition is satisfied, the event does not occur if the start function is disabled, but does occur if the start function is enabled. Stepped-execute the instruction before executing the rest of the user program, or disable the start function if you do not require it.
- If you intend to use a stop function, specify a subroutine which returns normally. If the specified subroutine does not return normally, the emulator debugger cannot control execution. To restore control, issue a reset of processing by the debugger.
- Hot plug-in is disabled while the start/stop facility is in use.

3.10.6. Emulation of Flash Memory CRC Accumulator Function

(1) High-speed CRC (code flash : all area)
The operation result of CRC is different from actual result. Because monitor program is arranged and reset vector is rewritten by on-chip debugging. Please check the operation of high-speed CRC by using IECUBE or using device without E1/E20.

(2) General-purpose CRC(code flash : specification area)
The operation result of CRC at following areas is different from actual result. Because monitor program is arranged and reset vector is rewritten by on-chip debugging.

- reset vector area
- debugging monitor area
- on-chip debugging option byte area
- software break setting area

3.10.7. Break Function

When "System" is selected in the [Monitor clock] property of the debugger, if a break occurs while operating on the sub clock, the E1/E20/E2 Lite switches the system clock to the main clock. Note the following in such a case.

- If the external clock (EXCLK) is set as the main clock, when a break occurs with the external clock stopped, an error will occur because the clock cannot be switched.
- Even if an SFR related to the clock is changed during a break, this change will be set in the device just before the user program is executed. Accordingly, the status flag does not change the moment the SFR is changed.
- When an SFR is rewritten to change the system clock to the sub clock during a break, though the E1/E20/E2 Lite switches to the sub clock just before the user program is executed, this sometimes results in an error after user program execution due to the oscillation stabilization wait time. In this case, set "User" for [Monitor clock] before debugging.

3.10.8. Events can be Set and Deleted during User Program Execution

Events can be set and deleted during user program execution. However, if a pin reset occurs after an event has been set or deleted, the contents of the event that was set or deleted during user program execution will be cleared.

3.10.9. Trace Function

When selecting not to permit flash memory rewriting with the debugger's property, the debug monitor area will not be located within 256 bytes below the end address of internal ROM. However, trace data cannot be acquired for this area.

3.10.10. Battery Backup Function

Debugging the battery backup function of the RL78/I1B is not supported.

E1/E20 Emulator, E2 Emulator Lite
Additional Document for User's Manual
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